

REMARKS

Applicants thank the Examiner for the Interview courteously granted to the undersigned, in connection with the above-identified application. During the Interview, propriety of the finality of the Office Action mailed December 11, 2000 was discussed, and the undersigned pointed out why this Office Action was an improper Final rejection. Description in Applicants' original disclosure, of the structure recited in claim 6, was pointed out by the undersigned during the Interview. Proposed illustrative claims having further recitations were presented to the Examiner during the Interview; and differences of these claims having the further recitations, from the previously applied prior art, were discussed. No agreement was reached during the Interview.

Applicants have amended their claims in order to further clarify the definition of the present invention. In particular, in response to Item 1 on page 2 of the Office Action mailed December 11, 2000, Applicants have canceled non-elected claim 8 without prejudice or disclaimer, and in particular without prejudice to the filing of a Divisional application directed to the subject matter thereof. In addition, Applicants have amended claim 28 to delete, in line 3 thereof, "or platinum", thereby overcoming the objection to claim 28 as set forth in Item 2 on page 2 of the Office Action mailed December 11, 2000.

Moreover, Applicants have amended the claims to clarify that the film adjacent to the copper or platinum is a "neighboring film", consistent with the description in the

paragraph bridging pages 3 and 4, as well as the paragraph bridging pages 4 and 5, for example, of Applicants' specification. This amendment is to contrast the neighboring film with the diffusion barrier layer made of, for example, titanium nitride, tungsten or tantalum. See, e.g., claim 9. In addition, independent claims 1, 2, 4, 6, 9 and 27 have been amended to recite that the neighboring film substantially prevents voids due to electromigration of the copper or platinum of, e.g., the copper or platinum film. Note, for example, the paragraph bridging pages 2 and 3 of Applicants' specification. Note also the paragraph bridging pages 3 and 4 of Applicants' specification. Note also the paragraph bridging pages 9-11 of Applicants' specification, and the paragraph bridging pages 12 and 13 of Applicants' specification. Furthermore, claims 3 and 5 have been amended to recite that the neighboring film is formed of the specified element or elements "as the primary constituent element", consistent with the description in the first full paragraph on page 32 of Applicants' specification. The "primary constituent element", as would have been known by the ordinary worker in the relevant art, is the element having the largest "atomic percentage"(at%) in the material of the film. Moreover, the subject matter of claim 26 has been incorporated into claim 25; and claim 26 has been canceled without prejudice or disclaimer. In addition, claim 21 has been canceled without prejudice or disclaimer.

Furthermore, Applicants have added new claims 30 and 31 to the application. Claim 30 recites the subject matter of

previously considered claim 27, and additionally recites that the neighboring film contains a material selected from the group consisting of rhodium, ruthenium, iridium, osmium and platinum "as the primary constituent element". Claim 31 recites subject matter set forth in previously considered claim 9, and additionally recites that the neighboring film, whether the copper or platinum film is recited, has "as the primary constituent element thereof", an element from the specified first or second group.

Initially, reconsideration and withdrawal of the finality of the Office Action mailed December 11, 2000, so that entry of the present amendments is then a matter of right, is respectfully requested. In this regard, the undersigned notes the rejection of claim 6, under the second paragraph of 35 USC 112, as set forth in Item 4 on pages 2 and 3 of the Office Action mailed December 11, 2000. This was the first time that claim 6 was rejected under the second paragraph of 35 USC 112, notwithstanding that Applicants did not amend claim 6 in the Amendment filed November 13, 2000, in the above-identified application. In view of this new rejection of claim 6, without amendment thereof in the immediately prior Amendment, it is respectfully submitted that the finality of the rejections in the Office Action mailed December 11, 2000, is clearly improper. The Examiner is not permitted to raise new rejections of claims which had not been amended, while making the rejection a Final rejection.

In any event, entry of the present amendments is respectfully requested. In this regard, note that while two

new claims are being added, finally rejected claims 21 and 26 are being canceled without prejudice or disclaimer. Accordingly, after entry of the present amendments, the number of claims to be considered on the merits in the present application is not greater than the number of finally rejected claims. Moreover, noting specific descriptions in Applicants' specification referred to previously, the present amendments clearly are not directed to new matter, nor even raise any issue of new matter. In addition, by further defining the present invention, it is respectfully submitted that the present amendments clearly materially limit any issues remaining in the application; and, at the very least, present the claims in better form for appeal. The present amendments clearly avoid the new rejection of claim 6, under the second paragraph of 35 USC 112. Furthermore, noting new contentions by the Examiner in the Office Action mailed December 11, 2000, as well as previous arguments by the Applicants, it is respectfully submitted that the present amendments are timely, and do not raise any new issues.

In view of all the foregoing, it is respectfully submitted that Applicants have made the necessary showing under 37 CFR 1.116(b); and that, accordingly, entry of the present amendments is clearly proper.

Applicants respectfully traverse the rejection of claim 6 under the second paragraph of 35 USC 112, as being indefinite, particularly insofar as applicable to claim 6 as presently amended. In particular, Applicants traverse the conclusion by the Examiner that Applicants do not "particularly point out

how both the first diffusion layer and the second diffusion layer are in contact with the plug and also in contact with each other", the Examiner referring to lines 4-7 of claim 6.

The Examiner's attention is respectfully directed to Fig. 9 and the description in connection therewith beginning on page 25 of Applicants' specification. The following is provided For illustration and explanation, and is not limiting of the present invention. Thus, note, for example, the structure represented by reference character 126a, which is a TiN film extending along a side of ruthenium plug 115. Attention is also directed to layer 116a, which is a neighboring film for copper film 117 and made of ruthenium. While not to be limiting, it is respectfully submitted that, for example, titanium nitride film 126a constitutes a diffusion barrier "formed in contact with said plug [e.g., 115] and said neighboring film [e.g., 116a]". Accordingly, clearly contrary to the allegation by the Examiner, Applicants' disclosure as originally filed describes how both the "first diffusion barrier" and the "second diffusion barrier" (now, respectively, a neighboring film and a diffusion barrier) are in contact with the plug and also in contact with each other. Accordingly, reconsideration and withdrawal of the rejection of claim 6 under the second paragraph of 35 USC 112 is respectfully requested, particularly in light of claim 6 as presently amended, defining, respectively, the neighboring film and diffusion barrier.

Applicants respectfully submit that all of the claims now presented for consideration by the Examiner patentably distinguish over the teachings of the references as applied by the Examiner in rejecting the claims as formerly in the application, that is, the teachings of the U.S. patents to Schacham-Diamand, et al., No. 5,824,599 (hereinafter "Diamand"), to Woo, et al., No. 6,054,331, to Zhao, et al., No. 5,674,787, and to Hussein, et al., No. 6,020,266, and the article entitled "Diffusion Barrier Between Copper and Silicon", in IBM Technical Disclosure Bulletin, vol. 35, no. 1B (June 1992), pages 214 and 215 (hereinafter IBM Technical Disclosure Bulletin), under 35 USC 102 and 35 USC 103.

It is respectfully submitted that the prior art as applied by the Examiner would have neither taught nor would have suggested such a semiconductor device as in the present claims, having the recited interconnection structure including the copper or platinum film, and having the neighboring film (1)made of a material selected from a first group consisting of rhodium, ruthenium, iridium, osmium and platinum when the layered interconnection structure includes a copper film and (2)made of a material selected from a second group consisting of rhodium, ruthenium, iridium and osmium when the layered interconnection structure includes a platinum film, with either the neighboring film or copper or platinum film being a film made by physical vapor deposition, and wherein the neighboring film substantially prevents voids due to electromigration of the copper or platinum of the copper or platinum film. See claims 1, 2, 6, 9 and 27; note also claims

4 and 6, specifying that the plug is formed of at least one film selected from the group consisting of films of specified materials, which substantially prevents the above-referred-to voids.

Moreover, it is respectfully submitted that the teachings of the applied references would have neither taught nor would have suggested such a semiconductor device as in the present claims, having the recited interconnect structure including the specified layers, and with the neighboring film formed of rhodium, ruthenium, iridium, osmium or platinum as the principal constituent element. See claims 3, 5, 30 and 31.

In addition, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such semiconductor device as in the present claims, having the recited interconnect structure and the neighboring film and/or plug, and wherein the copper film has a multilayered structure including a copper film formed through sputtering and a copper film formed through plating (see claim 1); or a copper film formed through physical vapor deposition and a copper film through chemical vapor deposition (see claim 2) or a copper film formed through sputtering and a copper film formed through plating or chemical vapor deposition (see claim 3); or at least one of the neighboring film(or plug) and a copper (or platinum) film is a film made by physical vapor deposition (see claims 4-6, 9 and 31; note also claims 27 and 30).

Furthermore, it is respectfully submitted that the teachings of these applied references would have neither

disclosed nor would have suggested such semiconductor device as in the present claims, having the copper film interconnect and neighboring film formed in contact with the copper film interconnect, and a plug formed in contact with the neighboring film, the plug being formed of a ruthenium film (see claims 4 and 5).

Moreover, the teachings of the applied references would have neither disclosed nor would have suggested the presently claimed invention as in the remaining, dependent claims, including (but not limited to) wherein specified layers are made by physical vapor deposition (see claims 13-15, 18-20, 23 and 29); and/or inclusion of the another neighboring film as in claim 28.

The present invention is directed to a semiconductor device having a layered (for example, multilayered) interconnect structure. In recent large-scale-integrated semiconductor devices, copper interconnects are being employed since they have a lower electrical resistance than conventional aluminum interconnects. However, diffusion of copper into silicon substrates or insulating films degrades characteristics of such devices; and, accordingly, diffusion barriers of, for example, titanium nitride, tungsten or tantalum have been used.

However, in large-scale-integrated semiconductor devices with fine patterns, in which high-density current occurs, electromigration (in which atoms are diffused owing to electron streams flowing in the fine patterns and due to heat generated by the flow of electrons) is a problem, causing

voids and interconnect breakdowns. Use of a diffusion barrier of, e.g., titanium nitride, does not provide satisfactory electromigration resistance.

Against this background, Applicants have clarified a source of the electromigration problem, and having clarified such source, have found a technique which overcomes the problem of voids due to electromigration and the resulting interconnect breakdown. Applicants have clarified that, in a layered interconnect structure using, for example, a titanium nitride film as a diffusion barrier kept in contact with the copper film, the significant difference between the material of the diffusion barrier and copper in the length of the sides of the unit cell brings about a disordered atomic configuration at the interface therebetween, thereby promoting copper diffusion that results in the problem of voids and interconnect breakdowns. Having clarified this problem, and in order to prevent the voids and breakdowns in copper interconnects, Applicants utilize materials that differ little from copper in a length of the sides of the unit cell. See the paragraph bridging pages 2 and 3 of Applicants' specification. Applicants have further found that where the difference between sides of the rectangular unit cells representing the copper and neighboring films is less than 13%, the aforementioned problem in voids and interconnect breakdowns are avoided.

In addition, Applicants have found specific materials, and also specific techniques for forming the various layers, whereby the aforementioned differential in lengths of sides of

the units cells are sufficiently small, so as to avoid the voids and interconnect breakdowns. That is, Applicants have found that by forming at least one of the adjacent layers of copper and neighboring film by physical vapor deposition,, with selection of material of the neighboring film, the aforementioned problem of voids can be avoided.

Attention is respectfully directed to Figs. 2-5 of Applicants' original disclosure, together with the description on pages 13-16 of Applicants' specification. This shows that the diffusion coefficient of the copper film greatly increases in regions where there is a great size differential. It is respectfully submitted that this evidence in Applicants' specification must be considered, in determining the question of unobviousness. See In re DeBlauwe, 222 USPQ 191 (CAFC 1984). It is respectfully submitted that this evidence shows unexpectedly lower diffusion occurs in connection with copper or platinum, on the one hand, and the various materials within the present claims, including ruthenium, on the other, where the difference in unit cell length is relatively small,. This evidence shows unexpectedly better results achieved according to the present invention, and clearly establishes unobviousness of the present invention.

Diamand discloses a technique for fabricating copper interconnects by electroless metallization, employing a copper catalytic layer to initiate the autocatalytic process of electroless deposition, and the use of a protective layer to protect the catalytic surface until the wafer is subjected to the electroless deposition technique. Note column 2, lines

50-56. Note also from column 6, line 13 to column 7, line 44. This patent discloses use of an adhesion promoter layer 16, a barrier layer 17 and a catalytic seed layer 18, this patent disclosing that the catalytic seed layer 18 can be of copper or comprised of nickel, cobalt, silver, gold, palladium, platinum or rhodium with copper. See column 7, lines 22-30.

It is emphasized that Diamand discloses use of the various listed metals with copper. The various listed metals in Diamand that can be used with the copper do not include ruthenium; and, moreover, this patent does not describe that the catalytic seed layer provides electromigration resistance. In fact, Diamand only discloses a catalytic seed layer as the layer of material including, e.g., nickel, cobalt, etc. It is respectfully submitted that the teachings of Diamand would have neither taught nor would have suggested, and in fact would have taught away from, the present invention, including, e.g., the neighboring film containing, for example, ruthenium as the primary constituent element, or substantially preventing voids due to electromigration through use of the recited neighboring film, or the other aspects of the present invention as discussed previously. Moreover, it is respectfully submitted that this reference does not teach, nor would have suggested, the plug of ruthenium, and advantages achieved thereby as discussed in Applicants' specification. Thus, clearly Diamand would not have anticipated the present invention as in claims 9, 10, 16, 17, 21, 22 and 24-27.

In connection with claims 11 and 12, Woo, et al. discloses a technique for deposition of a platinum film, used

as a bottom electrode of a capacitor in a high density DRAM and in a non-volatile memory cell including a FRAM memory cell. This patent discloses use of a functional intermediate film such as an insulating layer, a conductive plug layer, a diffusion barrier layer or an adhesive or glue layer formed between the platinum film and the substrate. See column 4, lines 28-51. These functional intermediate films include films used for adhesion or glue, including TiN, W, Ta, Ti, Sn, Ru, In, Ir, Os, Rh and silicide compounds. Note also column 5, lines 4-9 and 46-50 of this patent.

It is respectfully submitted that Woo, et al. would have neither taught nor would have suggested the presently claimed subject matter, including avoiding the problem in connection with electromigration as achieved according to the present invention. In this regard, note that Woo, et al. discloses use of various materials including TiN, W and Ti, for example, which do not achieve advantages according to the present invention. Note Figs. 2-5 of Applicants' original disclosure. Clearly, Woo, et al. does not teach, nor would have suggested, structure which includes a neighboring film that substantially prevents voids due to electromigration, as in claims 11 and 12.

It is respectfully submitted that the combined teachings of Hussein, et al. and the IBM Technical Disclosure Bulletin would have neither disclosed nor would have suggested the present invention as in claims 1-3, including wherein the neighboring film has ruthenium as the primary constituent

element or wherein the neighboring film substantially prevents voids due to electromigration.

Hussein, et al. discloses fabrication of via plugs and metal lines in interconnect systems, including a barrier layer formed onto a substrate surface that has at least one via, with a conductive layer formed on the barrier layer. This patent discloses that appropriate conductive material for the barrier layer may be titanium nitride or tantalum.

It is emphasized that Hussein, et al. discloses titanium nitride or tantalum for the barrier layer. As is clear from Applicants' original disclosure, use of titanium nitride or tantalum does not avoid problems in connection with electromigration. Clearly, the teachings of Hussein, et al. would have neither taught nor would have suggested the present invention, and advantages achieved thereby.

The IBM Technical Disclosure Bulletin discloses a diffusion barrier between copper and silicon, and describes that the diffusion barrier should be a material that does not interact with silicon and into which copper does not diffuse until at least 500°C. This article goes on to state that materials having large values of elastic constants C_{11} , C_{12} , and C_{44} can form barriers to diffusion of copper into silicon, and the metal that ideally fulfills these criteria is rhenium; and that similar desirable values, of elastic constants and eutectic temperatures, are a property of osmium, ruthenium and iridium.

It is emphasized that the IBM Technical Disclosure Bulletin describes a diffusion barrier including various

materials such as rhenium and rhenium oxide, as preferred materials. Attention is respectfully directed to the enclosed Sketches 1 and 2, prepared according to procedures corresponding to those set forth in connection with Figs. 2-5 of Applicants' original disclosure, and showing values for Re and ReO_3 . This shows disadvantageously a large diffusion for Re and ReO_3 . Particularly in light of the enclosed Sketches 1 and 2, it is respectfully submitted that the combined teachings of Hussein, et al. and of the IBM Technical Disclosure Bulletin would not have taught nor would have suggested the presently claimed subject matter, including avoidance of the electromigration achieved by the present invention and discussed previously.

The contention by the Examiner on page 5 of the Office Action mailed December 11, 2000, that a person of ordinary skill in the art would have been motivated to use a material from the IBM Technical Disclosure Bulletin as a copper diffusion barrier material in a structure of Hussein, et al., is noted. It is respectfully submitted, however, that the combined teachings of the applied references would have neither taught nor would have suggested unexpectedly better results achieved utilizing, for example, ruthenium, iridium, osmium and rhodium, or platinum where the interconnect is of copper, as in the present invention.

It is emphasized that according to the IBM Technical Disclosure Bulletin, large values of the elastic constants C_{11} , C_{12} , and C_{44} bring with them large values of activation energies for the barrier to interstitial diffusion, to achieve

desirable diffusion barriers. It is respectfully submitted that this general disclosure would have provided no teaching, or suggestion, of utilizing material having a relatively small difference in unit cell dimensions as clarified by Applicants, for achieving good neighboring films to substantially prevent voids due to electromigration, as achieved according to the present invention.

Contentions by the Examiner in the first full paragraph on page 6 of the Office Action mailed December 11, 2000, are noted. It must be emphasized that Applicants have clarified a technique for choosing desired materials, and using films formed by specified procedures, for avoiding electromigration, and provide layers having improved ability to avoid voids due to flow of copper or platinum by electromigration; this would have neither been taught nor suggested by the applied prior art. Moreover, materials providing greatest advantages according to the present invention, in view of the criteria clarified by Applicants, are different than those providing clear advantages in connection with the teachings of the IBM Technical Disclosure Bulletin, as described in the foregoing. Thus, it is respectfully submitted that the present situation is not a situation where Applicants have recognized "another advantage which would flow naturally from following the suggestion of the prior art".

In connection with claims 4 and 5, the teachings of Diamand and of the IBM Technical Disclosure Bulletin have previously been discussed. It is emphasized that Diamand utilizes the layer 18 as a catalytic seed layer, which, at the

least, is primarily of copper. One of ordinary skill in the art would not have looked to substitute the diffusion barrier layer of the Technical Disclosure Bulletin for the catalytic seed layer of Diamand. Alternatively, substituting materials of the Technical Disclosure Bulletin for the barrier layer of Diamand, this layer would not be in contact with the copper in view of the interposed seed layer.

Moreover, Diamand does not disclose, nor would have suggested, use of specified materials to substantially avoid voids caused by electromigration. As discussed previously, the criteria in the IBM Technical Disclosure Bulletin is different from that according to the present invention; and due to these different criteria the IBM Technical Disclosure Bulletin selects as the best materials, materials other than those according to the present invention that achieve best avoidance of electromigration. Even assuming, arguendo, that the teachings of Diamand and the IBM Technical Disclosure Bulletin were properly combinable, these combined teachings would have neither disclosed nor would have suggested substantial prevention of voids due to electromigration, or use of the layers containing the various materials as the primary constituent element, or other aspects of the present invention as discussed in the foregoing.

It is respectfully submitted that the combined teachings of Diamand, Woo, et al. and the IBM Technical Disclosure Bulletin would have neither disclosed nor would have suggested the aspects of the present invention as in claim 6, including the diffusion barrier layer in combination with the

neighboring film, with the copper interconnect, and advantages achieved thereby as discussed in the foregoing.

It is respectfully submitted that the additional teachings of Zhao, et al. would not have rectified the deficiencies of the teachings of Diamand and the IBM Technical Disclosure Bulletin, such that the subject matter of claim 28 would have been obvious to one of ordinary skill in the art. Zhao, et al. discloses a technique for selectively fabricating copper interconnect plugs by electroless metallization, including a dielectric encapsulation layer formed along the sidewalls of a via, with a contact displacement technique being used to form a thin activation layer of copper on a barrier metal, such as TiN, present as a covering layer on an underlying metal layer exposed through the via. This activation layer of copper operates as a seed to allow copper to electrolessly deposit within the via. This patent discloses that the dielectric encapsulation layer, bottom barrier layer and cap barrier layer function to encapsulate the copper plug in the via.

Even assuming, arguendo, that one of ordinary skill in the art would have looked to the teachings of Zhao, et al. and the IBM Technical Disclosure Bulletin in combination with the teachings of Diamand, such combined teachings would have neither disclosed nor would have suggested the aspects of the present invention as discussed previously, including substantially preventing voids through use of the neighboring film.

Furthermore, in connection with claims 13-15, 18-20, 23 and 29, the teachings of the references as applied in Item 14 on page 11 of the Office Action mailed December 11, 2000 would have neither taught nor would have suggested the present invention, including, inter alia, the neighboring film substantially preventing voids due to electromigration, and/or wherein the, e.g., ruthenium, iridium, osmium, etc., is a primary constituent element of the neighboring film, and advantages achieved thereby, as in the present invention.

Moreover, it must be emphasized that according to the present invention various of the layers are made by physical vapor deposition (e.g., sputtering), achieving advantages of improved surface such that prevention of voids due to electromigration is facilitated. It is respectfully submitted that the teachings of the applied references do not disclose, nor would have suggested, such aspect of the present invention (e.g., structure of the surface of the layer formed by the physical vapor deposition) .

The contention by the Examiner that the product as claimed, in a product-by-process claim, must be patentable, is noted. It is respectfully submitted, however, that as shown by the foregoing discussion of improved, e.g., surface characteristics achieved when the layers are formed by processing recited in the present claims, the processing according to the present invention provides a product having advantages. Such product having advantages, different from the prior art structure, provides a basis for patentability. See In re Luck, 177 USPQ 523, 525 (CCPA 1973).

Furthermore, various of the present claims recite that the copper interconnect is a multilayer structure, e.g., layers of copper respectively formed by, e.g., sputtering or physical vapor deposition and, e.g., plating or chemical vapor deposition. It is respectfully submitted that such multilayer structure, as part of the presently claimed structure, would have been neither taught nor would have been suggested by the teachings of the applied references.

In view of all of the foregoing, reconsideration and withdrawal of the finality of the Office Action mailed December 11, 2000, and reconsideration and allowance of all claims remaining in the application, are respectfully requested.

In any event, entry of the present amendments, and reconsideration and allowance of all claims remaining in the application, are respectfully requested.

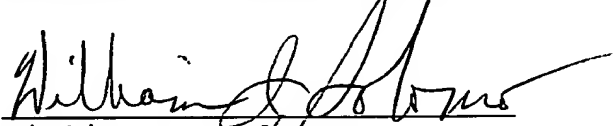
Attached hereto is a marked-up version of the changes made in the claims by the current Amendment. This marked-up version is on the attached pages, the first page of which is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE".

To the extent necessary, Applicants petition for an

extension of time under 37 CFR § 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Deposit Account No. 01-2135 (Case No. 501.36931X00) and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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A handwritten signature in dark ink, appearing to read 'William I. Solomon', is written over a horizontal line.

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS

Please cancel claims 8 and 26 without prejudice or disclaimer, and amend the claims remaining in the application as follows:

1. (Amended) A semiconductor device with a [layered] multilayered structure comprising a copper film interconnect formed on one primary surface of a semiconductor substrate, and a [diffusion barrier] neighboring film formed in contact with said copper film interconnect, wherein said [diffusion barrier] neighboring film is formed of a ruthenium film which substantially prevents voids due to electromigration of copper of the copper film, and said copper film interconnect has a [layered] multilayered structure comprising a copper film as formed through sputtering and a copper film as formed through plating.

2. (Amended) A semiconductor device with a [layered] multilayered structure comprising a copper film interconnect formed on one primary surface of a semiconductor substrate, and a [diffusion barrier] neighboring film formed in contact with said copper film interconnect, wherein said [diffusion barrier] neighboring film is formed of a ruthenium film which substantially prevents voids due to electromigration of copper of the copper film, and said copper film interconnect has a [layered] multilayered structure comprising a copper film as

formed through physical vapor deposition and a copper film as formed through chemical vapor deposition.

3. (Amended) A semiconductor device with a multilayered [layered] structure comprising a copper film interconnect formed on one primary surface of a semiconductor substrate, and a [diffusion barrier] neighboring film formed in contact with said copper film interconnect, wherein said [diffusion barrier] neighboring film is formed of [a] ruthenium [film] as the primary constituent element, [as] and is formed through sputtering, and said copper film interconnect has a [layered] multilayered structure comprising a copper film as formed through sputtering and a copper film as formed through plating or chemical vapor deposition.

4. (Amended) A semiconductor device with a structure comprising a copper film interconnect formed on one primary surface of a semiconductor substrate, and a plug formed in contact with said copper film interconnect, wherein said plug is formed of at least one film selected from the group consisting of rhodium film, a ruthenium film, an iridium film, an osmium film and a platinum film, which substantially prevents voids due to electromigration of copper of the copper film, and at least one of said copper film interconnect said plug contains a layer as formed through physical vapor deposition.

5. (Amended) A semiconductor device with a structure comprising a copper film interconnect formed on one primary surface of a semiconductor substrate, a [diffusion barrier] neighboring film formed in contact with said copper film interconnect, and a plug formed in contact with said [diffusion barrier] neighboring film, wherein said [diffusion barrier] neighboring film is formed of [a] ruthenium as the primary constituent [film], said plug is formed of [a] ruthenium as the primary constituent [film], and at least one of said copper film interconnect and said plug contains a layer as formed through physical vapor deposition.

6. (Amended) A semiconductor device with a structure comprising a copper film interconnect formed on one primary surface of a semiconductor substrate, a [first diffusion barrier] neighboring film formed in contact with said copper film interconnect, a plug formed in contact with said [first diffusion barrier] neighboring film, and a [second] diffusion barrier formed in contact with said plug and said [first diffusion barrier] neighboring film, wherein said [first diffusion barrier] neighboring film is formed of a ruthenium film, said plug is formed of a ruthenium film, said [second] diffusion barrier is formed of a titanium nitride film, and at least one of said copper film interconnect and said [first diffusion barrier] neighboring film is a film formed through sputtering, wherein the neighboring film and the plug substantially prevent voids due to electromigration of the copper or platinum of the copper or platinum film.

9. (Amended) A semiconductor device having a layered interconnection structure including a copper film or a platinum film formed overlying a surface of a semiconductor substrate, wherein the layered interconnection structure includes the copper or platinum film and a neighboring film adjacent the copper or platinum film, the neighboring film being made of a material selected from a first group consisting of rhodium, ruthenium, iridium, osmium and platinum. when the layered interconnection structure includes a copper film and the neighboring film is made of a material selected from a second group consisting of rhodium, ruthenium, iridium and osmium when the layered interconnection structure includes a platinum film, at least one of (a) the copper or platinum film and (b) the neighboring film being a film made by physical vapor deposition, the device further comprising a diffusion barrier layer, said neighboring film being sandwiched between said copper or platinum film and said diffusion barrier layer, wherein the neighboring film substantially prevents voids due to electromigration of the copper or platinum of the copper or platinum film.

25. (Amended) The semiconductor device according to claim 24, further comprising another diffusion barrier layer between the plug and the further neighboring film, wherein the another diffusion barrier layer is at least one film made of material selected from the group consisting of titanium nitride, tungsten and tantalum.

27. (Amended) A semiconductor device having a layered interconnection structure including a copper film formed overlying a surface of a semiconductor substrate, wherein the layered interconnection structure includes the copper film and a neighboring film adjacent the copper film, the neighboring film being made of a material selected from a group consisting of rhodium, ruthenium, iridium, osmium and platinum, at least one of (a) the copper film and (b) the neighboring film being a film made by physical vapor deposition, wherein the neighboring film substantially prevents voids due to electromigration of copper of the copper film.

28. (Amended) The semiconductor device according to claim 27, further comprising another neighboring film, adjacent a side of the copper [or platinum] film opposite a side thereof having said neighboring film adjacent thereto, said another neighboring film being made of a material selected from the group consisting of rhodium, ruthenium, iridium, osmium and platinum.